

forming a metal mold with a specific scale, feeding molten material at a desired temperature into the cylinder, injecting the molten material into the impression at a specific speed, and cooling the molten material to solidify. With such a method, a cap without draft allowance is formed, such that the process for forming the cap is simplified and the cost for manufacturing the cap is reduced.

Other objects, advantages and novel features of the invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross sectional side plan view of a cap formed with a method in accordance with the present invention; and

Fig. 2 is a side plan view in partial cross section of a metal mold for forming the cap in Fig. 1.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

With reference to Fig. 1, a cap (30) for a pneumatic gun in accordance with the present invention comprises a body with a closed first end wall and a second end wall. An opening is defined in the second end wall of the body and has a floor parallel to an edge of the second end wall of the body. An annular flange (31) perpendicularly extends from the floor in the opening. No draft allowance is arranged in the cap (30) as will be described in more detail later.

To form the cap (30) without draft allowances, with reference to Figs. 1 and 2, a metal mold constructed of a female portion (10), a male portion (20) and a cylinder (11) is provided. An impression (100) with a shape substantially equal to that of the cap (30) is defined between the portions (10,20). Multiple cooling channels (13) are defined in

the portions halves (10,20) and extend around the impression (100). The portions (10,20) are selectively made of SKD 61 alloy tool steel. The hardness of the portions (10,20) is in a range H_{RC} 45 to 50. A heat treatment must be applied to the surface of the portions (10,20) to increase the hardness of the surface of the portions (10,20) to H_{RC} 70 with a depth 0.25 mm (millimeter). The smoothness of the surface of the portions (10,20) is 800μ .

The cylinder (11) is connected to one of the portions (10,20) and is communicated with the impression (100) through an injecting passage (102). A piston (12) is moveably mounted in the cylinder (11) to force molten material such as Aluminium into the impression (100). The preferred temperature of the molten Aluminum is 650 to 680 °C. A sprue (110) is defined in the cylinder (11) for the molten material to be fed into the cylinder (11).

To inject the molten material into the impression (100), the piston (12) presses the molten material into the injecting passage (102) at a low speed 1.5 m/s (meters per second) firstly to avoid the air of the environment from being sucked into the cylinder (11) through the sprue (110). The molten material is then forced into the impression (100) at a speed 4.5 m/s. The air in the impression (100) will be forced into an air chamber (101) communicating with the impression (100). In practice, the air chamber (101) is connected to an air pump (not shown) to exhaust the air from the impression (100) and the air chamber (101), such that this can avoid gas bubbles forming in the cap (30). The pressure provided by the piston (12) to the molten material is increased to $220\text{kg}/\text{cm}^2$ so that the density of the molten material is increased. The molten material is cooled to between 180 and 200 °C in 20 to 25 seconds due to cool water passing along the cooling channels, whereby the molten material solidifies as the cap (30). When the cap (30) has

1 cooled and its volume decreased in comparison to its hot state, a gap will be defined
2 between the cap (30) and the inner surface of the impression (100) due to the contraction
3 of the cap (30). The gap can help the cap (30) to be ejected from the mold without draft
4 allowance. Thus, the cap (30) can be directly mounted on a pneumatic gun without any
5 additional work. Accordingly, the process for manufacturing the cap (30) is simple, and
6 the cost for manufacturing the cap (30) is low. In addition, multiple pins (21) are
7 mounted in the mold to push the cap (30) to release it from the mold.

8 In addition, to improve the convenience of releasing the cap (30) from the mold,
9 an isolating agent is previously sprayed onto the inner surface of the impression (100)
10 before the die casting process is undertaken. The agent is a mixture of 10% ester, 4%
11 vegetable oil, 6% silicon oil, 1% polymer and 79% water. The agent is diluted with
12 water at a ratio 1:120 when the agent is used.

13 Even though numerous characteristics and advantages of the present invention
14 have been set forth in the foregoing description, together with details of the structure and
15 function of the invention, the disclosure is illustrative only, and changes may be made in
16 detail, especially in matters of shape, size, and arrangement of parts within the
17 principles of the invention to the full extent indicated by the broad general meaning of
18 the terms in which the appended claims are expressed.